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Forest Insect And Disease Management

Spruce Beetle
Risk Rating System
for White Spruce on
the Kenai Peninsula

Chugach National Forest

Technical Report R10-1

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U.S. Department of Agriculture
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Introduction

Historically, throughout the contiguous United States and Alaska, forest administrators have "managed" spruce beetle (*Dendroctonus rufipennis* Kby.) populations with a post mortem attitude (Schmid and Frye 1976). Action was usually initiated after infestations reached outbreak status associated with substantial timber kill. Such an approach is becoming unacceptable in view of the demand for more intensive management and use of publicly owned forests. Forest managers need a method of identifying potential outbreak areas. Managers could then direct actions to high-priority stands resulting in a reduction in the number as well as the severity of future outbreaks (Schmid and Frye 1976).

Objective

A. The principal objective of this paper is to present a Risk Rating System for Alaska's southcentral white spruce forests (*Picea glauca* [Moench] Voss.) occurring on the Chugach National Forest. A brief discussion of the history and life cycle of the spruce beetle in Alaska is presented in the Appendix. A general discussion of pest conditions occurring in Sitka spruce forests (*P. sitchensis* [Bong] Carr.)

is presented in the Results and Discussion Section. No attempt was made to risk rate these stands as the spruce beetle outbreak potential is low.

Materials and Methods

Information used for risk rating white spruce stands was obtained from the Chugach National Forest Planning Unit #1 (Kenai Peninsula). The Planning Unit has been divided into Capability Areas (C.A.'s) which are based on watersheds. There are twenty-two C.A.'s containing white spruce; a total of 186 stands were risk rated.

A. The Risk Rating System is based on the stand rating system developed for Englemann spruce - subalpine fir stands (*P. engelmannii* Parry and *Abies lasiocarpa* [Hooker] Nattall, respectively) in the Rocky Mountain Region by Schmid and Frye (1976). Their system is based on physiographic location, tree diameter, basal area and percentage of spruce in the canopy. Because some of the information was not available for all white spruce stands on the Chugach National Forest, the following Risk Rating System is based on Average Diameter, Stand Age, Stand Condition and Proportion of White Spruce in the Canopy (Table 1). For a discussion of these factors with respect to white spruce susceptibility, refer to Appendix A. Each of the four stand characteristics is rated from 1 (low risk)

to 3 (high risk). These rating values are added together and the total becomes the stand risk value which is used to classify the stand as having a high, medium to high, medium, low to medium, or a low outbreak potential (Table 2).

B. To calculate the risk rating for a hypothetical stand, assume these characteristics: (1) Sawtimber, 9-12" d.b.h. [11] 1/; (2) old growth, 151-200 years [12]; (3) Stand Condition, old growth sawtimber, 8 m.ft./acre [4] and (4) proportion of white spruce in canopy $>$ 70% [44]. Comparing these values to the risk rating in Table 1, values of 2,3,3 and 3 are obtained. Adding these together gives a value of 11 which translates into a high Potential Outbreak Rating (Table 2). If the value was 4 or 5, or 7 to 9, the potential outbreak rating would be low and medium, respectively.

Tables 3 and 4 summarize the potential outbreak rating for each white spruce stand within the 22 C.A.'s. A weighted risk value is given for each C.A. This weighted risk value was determined by multiplying each stand risk

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1/ Numbers in brackets refer to code describing stand characteristics. Coding procedures were taken from the Chugach National Forest Land Classification System.

value by its percent of overall white spruce acreage in a particular C.A. The stand weighted risk values are added together to give an overall weighted risk value for a particular C.A.

Results and Discussion

A. Fifty-two percent of the stands in Planning Unit #1 have a medium potential outbreak rating; 11 percent are medium to high; 21 percent are high; the rest were rated low, low to medium (Table 3). With respect to the C.A.'s, 82 percent have a medium weighted potential outbreak rating; 5 percent are medium to high and 14 percent have been rated as high (Table 4).

1. For purposes of compatability with the Chugach Planning Unit, a high potential outbreak rating for a given C.A. is designated as a 5; a low rating is a 1 (Table 2).

B. It must be kept in mind that the outbreak ratings refer to potential problems. They are based on present knowledge of spruce beetle behavior and factors associated with stand susceptibility (see Appendix A). Thus, if blowdown or dry, warm summer weather occurs in a high risk stand or C.A., there is a very good chance that an increase in spruce beetle

activity will take place. In fact, two stands in C.A. 11 were rated as having high outbreak potentials. These stands are located within the Resurrection Creek drainage. Blowdown occurred in these stands and a large spruce beetle outbreak occurred (Holsten et.al, 1979). There are other stands with high outbreak potentials which now have increased beetle activity. The forest manager may have additional information such as blowdown potential, climatic conditions which can also be considered in deciding whether a stand should be given a higher or lower rating. This has already been done to a limited degree. Table 4 has a revised risk category. Each stand that was initially rated as high or medium-high was double checked according to stand location. Stands located in the Cook Inlet Basin have a higher spruce beetle risk than white spruce stands influenced by the maritime conditions of Prince William Sound. Only 17 stands out of 59 high and medium-high rated stands had their ratings changed. In all 17 cases, the risk ratings were lowered. These stands are located near Seward.

C. Forest Stands in the Prince William Sound and Afognak Island areas were not risk rated as to potential spruce beetle outbreaks. Few outbreaks have been recorded from localities influenced by maritime conditions which are characterized

by Sitka spruce-hemlock (*Tsuga heterophylla* [Ref.] Sarg.) forests. Outbreaks have occurred (Copper River, Afognak Island) but they are rare. Due to this apparent low risk status and also in part due to lack of information concerning spruce beetle behavior in coastal forests, those C.A.'s of the Chugach National Forest containing Sitka spruce should be considered low to low-medium (1 and 2) risks. Those stands that have more than 70 percent old growth Sitka spruce with relatively high basal areas should be considered low to medium, and possibly medium risk areas. Hopefully at a later date, an adequate risk rating system can be devised for Sitka spruce-hemlock forests.

1. As previously mentioned, spruce beetles are one of the most important of mortality agents in southcentral Alaska white spruce forests; they play a minor role in Sitka spruce-hemlock forests. Apart from the spruce beetle, few insects or diseases are important mortality agents on the Chugach National Forest. Small pockets of occasional defoliation, root rots, and foliage diseases appear, but these have been of minor concern in the past. As management intensifies we would expect some of these other pests to play a more important role in the planning effort which results in management direction.

Conclusions

The intent of this rating system is to identify the outbreak potential of each unmanaged white spruce stand or C.A., rather than to tell the manager how to manage (Schmid and Frye 1976). It is the manager's decision whether to cut or not, but he does so realizing that many stands are carried under high risk. Based on this risk rating system the forest manager has another tool for managing white spruce forests and beetle populations. We recognize that this risk rating system is based on only four stand characteristics which represent only a fraction of the factors that could be used. However, this risk rating system will be refined as soon as additional stand information is available (e.g. basal area, site characteristics, etc.).

Appendix A

A. Alaska white spruce (*Picea glauca* [Moench] Voss) forests are subject to mortality from a variety of causes: wind, disease, fire and insect outbreaks. Of all the insects, the spruce beetle (*Dendroctonus rufipennis* Kby.) is the most devastating.

Periodically, spruce beetle infestations increase rapidly causing widespread damage. One such outbreak caused about 81,000 hectares (200,000 acres) of tree mortality along the Copper and Chitina Rivers from approximately 1920 to 1930 (Downing 1957). Factors contributing to that outbreak are not known. In the early 1960's spruce beetle infestations on the Kenai Peninsula covered approximately 105,220 hectares, with losses estimated at two hundred million cubic feet (Curtis and Swanson 1972). In 1972, an outbreak was reported from Tyonek on the west side of Cook Inlet. Three years later this outbreak extended over 115,130 hectares (Baker and Curtis 1972). In 1974 and 1975, one hundred hectares of scattered white spruce blowdown occurred along Resurrection Creek near Caribou Creek approximately 17 kilometers from Hope, Alaska. By 1978, this infestation covered approximately

6,070 hectares (Holsten et.al. 1979). For the most part, spruce beetle infestations are a recurrent and serious problem in southcentral Alaska.

On the other hand, spruce beetle infestations are sporadic and rare in southeast Alaska. A spruce beetle outbreak on Kosciusko Island destroyed an estimated 7.1 million cubic feet of Sitka spruce (*P. sitchensis* [Bong] Carr.) on a 2,592 hectare tract during the early 1940's (Keen 1952). It is believed that sub-optimal climatic conditions for spruce beetle development are the main reasons for low levels of spruce beetle activity in southeast Alaska. Spruce beetles attack black spruce (*P. mariana* [Mill.] B.S.P.), Sitka spruce and most commonly white spruce.

B. The Life Cycle of the spruce beetle in Alaska is generally two years in duration. However, where optimal climatic conditions exist, a generation can be produced in one year. On the other hand, sub-optimal climatic and breeding conditions can prolong development for three years. Adult beetles emerge from infested trees early in spring. Females select fresh host material and begin boring into the bark. Egg galleries are constructed in the phloem parallel to the wood grain. After mating, eggs are deposited in clusters on either side of the

gallery. Larvae feed in the phloem cross-wise to the egg gallery. Larvae do not enter the wood but may score the outer layer (Werner 1978). The insects spend the first winter as larvae beneath the bark. The following spring and summer development continues. Adults emerge from the now dead or dying tree and move to fresh trees. However, many adults re-enter the same tree at its base, where they overwinter. Attacking beetles emerge the following spring (Werner 1978).

C. Types of Spruce Material Infested:: The previously mentioned large outbreaks have usually occurred in an area between the moisture-laden southeast, characterized by Sitka spruce, and the more arid continental interior where spruce beetles are common, but outbreaks rare (Werner et.al. 1977). Recent outbreaks in the Cook Inlet basin were associated with warm dry summers in 1968-69 and 1976-78. These outbreaks also occurred in a forests containing a high percentage of large diameter white spruce (Baker and Kemperman 1974, Holsten et.al. 197 accumulations of spruce debris resulting from forest clear seismic exploration and blowdown. Such material is highly productive as breeding sites for this insect (Schmid and Frye 1977). When populations increase and sufficient down material is no longer available to absorb the

Table 1---Risk Characteristics for Potential Spruce Beetle Outbreaks in Alaska White Spruce Stands

Risk Category	Average diameter of white spruce (Inches D.B.H.)	Stand Age	Stand Condition	Proportion of White Spruce in Stand
HIGH [3] 1/	>12 (10, 12 - 17) 2/	Old growth (10 - 13, 43)	- Damaged sawtimber (03) - Old growth (04 - 08) - Primary or second growth sawtimber not at rotation (10)	>70(44)
MEDIUM [2]	9 - 11.9 (10, 11)	Second Growth (20 - 23, 42)	- Damaged pole timber (02) - Mature pole timber (09) - Primary or second growth pole timber (11)	50(12)
LOW [1]	<8.9(20 - 22, 30 - 34)	Seedlings and Saplings (30 - 34, 41)	- Seedlings and Saplings (01, 12, 13)	----

1/ Numbers in brackets represent an arbitrary value used in calculating risk rating.

2/ Numbers in parentheses are forest land classification codes used on the Chugach National Forest.

Table 2---Potential Outbreak Rating System

Stand Risk Value 1/	C.A. Rating	Potential Outbreak Rating
11 - 12	5	HIGH
10	4	MEDIUM - HIGH
7 - 9	3	MEDIUM
6	2	LOW - MEDIUM
4 - 5	1	LOW

1/ From Table 1.

Table 3---Summary of Potential Outbreak Ratings in Planning Unit #1

Risk	# Stands	Acres	Av. Ac./Stand
High	39	4943	126.74
Medium-High	20	2381	119.05
Medium	96	9828	102.38
Low-Medium	19	1509	79.42
Low	12	1196	99.67
	186	19857	106.76

Table 4---Stand and Compatability Area Ratings
with Regard to Potential Spruce Beetle Outbreaks

C.A.	Stand	Acres	%	Old Risk	New Risk 1/	Wt. Risk 2/
1	2	112	26	10		2.60
	5	291	67	7		4.69
	11	33	8	11		.88
		436			Total	[8.17] (3) 3/
2	1	600	32	7		2.24
	2	365	19	11		2.09
	4	204	11	7		.77
	5	144	8	5		.40
	6	590	31	10		3.10
		1903			Total	[8.60] (3)
4	2	270	29	10		2.90
	33	369	40	8		3.20
	7	35	4	6		.24
	9	55	6	11		.66
	10	205	22	5		1.10
		934			Total	[8.10] (3)
5	4	150	25	5		1.25
	1	147	24	8		1.92
	2	59	10	8		.80
	8	83	14	8		1.12
	11	55	9	11		.99
	12	30	5	7		.35
	13	23	4	11		.44
	15	61	10	11		1.10
		608			Total	[7.97] (3)

1/ New Risk - Stands which were intitally rated medium-high or high were located on 1:63,000 USGS maps and due to their geographic location remained the same or were reduced.

2/ Weighted Risk - Each Stand-Risk was multiplied by its percent acreage. Stand Weighted Risks were added to give an overall C.A. rating.

3/ Number in parentheses is C.A. Rating for potential outbreak: 1 = Low, 5 = High.

C.A.	Stand	Acres	%	Old Risk	New Risk	Wt. Risk	
6	4	13	1	10	9	.09	
	5	535	43	8		3.44	
	6	104	8	8		.64	
	7	135	11	8		.88	
	9	125	10	8		.80	
	34	256	21	8		1.68	
	36	65	5	6		.30	
		1233			Total	[7.83]	(3)
7	23	31	1	11		.11	
	24	51	2	11		.22	
	25	72	3	11		.33	
	26	72	3	11	9	.27	
	35	21	1	11		.11	
	63	12	.05	8		.04	
	64	56	2	11		.22	
	65	73	3	11		.33	
	33	22	1	11	10	.10	
	34	21	1	11	10	.10	
	36	217	8	12	10	.80	
	45	31	1	10		.10	
	49	120	4	7		.28	
	50	62	2	6		.12	
	51	20	1	8		.08	
	69	211	8	11		.88	
	1	64	2	11	10	.20	
	2	141	5	8		.40	
	3	363	13	8		1.04	
	8	186	7	6		.42	
	10	276	10	6		.60	
	11	74	3	8		.24	
	12	79	3	8		.24	
	13	27	1	6		.06	
	14	72	3	8		.24	
	15	23	1	10		.10	
	16	104	4	6		.24	
	17	31	1	6		.06	
	18	46	2	6		.12	
	20	113	4	6		.24	
		2691				[8.29]	(3)
11	1	133	11	11		1.21	
	2	1064	89	11		9.79	
		1197			Total	[11.00]	(5)

C.A.	Stand	Acres	%	Old Risk	New Risk	Wt. Risk
12	7	115	8	7		.56
	8	13	1	11		.11
	30	22	2	7		.14
	31	164	12	11		1.32
	35	708	52	8		4.16
	36	342	25	7		1.75
		1365			Total	[8.04] (3)
13	2	387	50	11		5.50
	5	103	13	11		1.43
	8	43	6	8		.48
	9	107	14	8		1.12
	11	130	17	11		1.87
		770			Total	[10.40] (4)
14	1	84	47	8		3.76
	3	96	53	8		4.24
		180			Total	[8.00] (3)
15	7	79	51	8		4.08
	10	69	45	8		3.60
	12	7	4	11		.44
		155			Total	[8.12] (3)

C.A.	Stand	Acres	%	Old Risk	New Risk	Wt. Risk
18	4	14	1	5		.05
	2	51	3	8		.24
	3	11	1	7		.07
	4	87	4	5		.20
	5	27	1	8		.08
	1	42	2	10		.20
	2	66	3	6		.18
	7	21	1	8		.08
	10	62	3	8		.24
	11	84	4	6		.24
	13	45	2	8		.16
	14	74	4	6		.24
	18	20	1	7		.07
	20	53	3	5		.15
	21	38	2	8		.16
	22	20	1	9		.09
	23	94	5	5		.25
	24	95	5	9		.45
	26	48	2	6		.12
	27	65	3	5		.15
	29	56	3	6		.18
	33	87	4	6		.24
	52	39	2	8		.16
	57	263	13	8		1.04
	60	207	10	8		.80
	64	50	2	8		.16
	65	93	5	11		.55
	66	190	9	11		.99
	67	30	1	11		.11
	68	8	.03	6		.002
		2040			Total	[7.65] (3)
20	20	91	49	8		3.92
	39	39	21	11	9	1.89
	42	55	30	8		2.40
		185			Total	[8.21] (3)
21	6	32	42	7		2.94
	20	45	58	7		4.06
		77			Total	[7.00] (3)

C.A.	Stand	Acres	%	Old Risk	New Risk	Wt. Risk	
23	9	135	8	11	9	.72	
	10	158	10	11	10	1.00	
	11	45	3	8		.24	
	12	145	9	10	9	.81	
	14	10	1	9		.09	
	16	37	2	11	10	.20	
	17	35	2	8		.16	
	18	207	13	8		1.04	
	19	177	11	11	10	1.10	
	21	24	2	7		.14	
	22	81	5	8		.40	
	23	139	9	5		.45	
	27	169	11	11	10	1.10	
	29	86	5	7		.35	
	30	147	9	5		.45	
		1595			Total	[8.25]	(3)
24	1	54	14	11	9	1.26	
	2	43	11	9		.99	
	4	18	5	9		.45	
	6	60	16	8		1.28	
	7	200	53	11	9	4.77	
		375			Total	[8.75]	(3)
25	1	149	51	11	9	4.59	
	2	78	27	7		1.89	
	5	66	23	11	9	2.07	
		293			Total	[8.55]	(3)
26	46	73	33	11		3.63	
	47	18	8	11		.88	
	49	63	29	12		3.48	
	50	67	30	12		3.60	
		221			Total	[11.59]	(5)
27	38	84	26	6		1.56	
	44	91	28	8		2.24	
	45	143	44	11		4.84	
	46	6	2	8		.16	
		324			Total	[8.80]	(3)

C.A.	Stand	Acres	%	Old Risk	New Risk	Wt. Risk
28	2	103	5	7		.35
	3	144	7	8		.56
	6	156	7	11		.77
	7	158	7	9		.63
	9	50	2	11		.22
	10	69	3	10		.30
	11	27	1	9		.09
	13	38	2	10		.20
	14	30	1	5		.05
	15	61	3	8		.24
	16	151	7	10		.70
	18	68	3	11		.33
	19	182	9	11		.99
	20	32	2	8		.16
	21	31	2	10		.20
	22	259	12	11		1.32
	24	45	2	6		.12
	25	101	5	11		.55
	26	72	3	8		.24
	27	21	1	8		.08
	28	126	6	11		.66
	34	68	3	5		.15
	35	37	2	8		.16
	37	60	3	6		.18
		2089			Total	[9.25] (3)
31	10	40	3	11		.33
	11	59	4	11		.44
	4	14	1	8		.08
	14	181	12	8		.96
	19	146	10	8		.80
	20	33	2	10		.20
	22	68	5	8		.40
	23	82	5	8		.40
	24	95	6	9		.54
	25	99	7	11		.77
	27	28	2	8		.16
	28	44	3	7		.21
	29	28	2	8		.16
	30	14	1	9		.09
	31	50	3	8		.24
	32	33	2	11		.22
	33	29	2	9		.18
	34	74	5	10		.50
	35	207	14	8		1.12
	36	52	3	8		.24
	37	28	2	8		.16
	38	87	6	7		.42
		1491			Total	[8.62] (3)

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